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Inventor (s): Takeshi TAKASE



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Pillsbury Winthrop LLP

☐ Provisional Application

☒ Regular Utility Application

☐ Continuing Application

☐ The contents of the parent are incorporated by reference

☐ PCT National Phase Application

☐ Design Application

☐ Reissue Application

☐ Plant Application

☐ Substitute Specification

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SPECIFICATION

METHOD FOR MANUFACTURING FLAT DISPLAY ELEMENT

This application is based upon and claims the benefit of priority from the prior Japanese Patent Applications No. 2000-383882, filed December 18, 2000; and No. 2001-318368, filed October 16, 2001, the entire contents of both of which are incorporated herein by reference.

1. Field of the Invention

2. Description of the Related Art

In recent years, flat display elements have widely been used as image display units of portable equipments for office automation, computer terminals, TV sets, etc. Usually, one such flat display element comprises a pair of electrode substrates opposed to each other across a given gap and an optical modulation layer, such as a liquid crystal, sealed between the electrode substrates. The respective peripheral edge portions of the electrode substrates are hermetically sealed with a

These spacers are generally formed of a resin
5 sphere each and are distributed at random in the
display region of the electrode substrates. In a
liquid crystal display device having a liquid crystal
sealed in a display cell, therefore, the spacers
disturb the orientation of liquid crystal molecules and
the like, and their unbalanced distribution may
10 possibly cause uneven display.

20 The display cell used in one such flat display
element is manufactured in the following steps. First,
two mother glass plates each having a display cell
forming region are prepared. A sealant and a dummy
sealant are spread on the one mother glass plate so as
25 to surround the forming region, and a tacker for
preventing misalignment with the object mother glass
plate is applied to end portions of the one mother

glass plate.

Subsequently, the two mother glass plates are opposed to each other, and are roughly aligned by means of a plane mounter so that the shift of the pixel patterns that are opposed to one another in the display region of the flat display element is within about 5 μ m. Thereafter, the two mother glass plates are pressed and stuck on each other. Then, the mother glass plates are aligned with each other to lessen the shift of the pixel patterns. Thereafter, the tacker is cured to tack the two mother glass plates to each other, and moreover, the sealant and the dummy sealant are cured.

If the two mother glass plates are stuck on each other after they are aligned by means of the plane mounter, according to the manufacturing method described above, however, the tacker inevitably collapses, thereby causing the respective end portions of the mother glass plates to adhere to each other. In aligning the mother glass plates to lessen the pixel pattern shift by means of an aligner, therefore, the mother glass plates cannot be smoothly moved with respect to each other. Thus, the alignment takes a lot of time, so that the productivity lowers.

BRIEF SUMMARY OF THE INVENTION

The present invention has been contrived in consideration of these circumstances, and its object is

to provide a manufacturing method for a flat display element, in which alignment time is shortened so that productivity is improved.

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In order to achieve the above object, according to an aspect of the present invention, there is provided a method for manufacturing a flat display element provided with a pair of substrates opposed to each other across a given gap and having the respective peripheral edge portions thereof stuck on each other with a sealant. This method comprises: preparing a pair of motherboards greater than the substrates; forming a display forming portion on each motherboard; locating the sealant on at least one of the motherboards so as to surround the peripheral edge portion of the display forming portion and locating, on the end portions of the motherboard, end spacers for maintaining the gap between the two motherboards and a tacker covering the end spacers; sticking the two motherboards on each other with the sealant, end spacers, and tacker between the two; aligning the two stuck motherboards with each other; tacking the two motherboards to each other by curing the tacker after the aligning; finally bonding the two motherboards to each other by curing the sealant after the tacking; and cutting the two motherboards outside the sealant after the final bonding so as to obtain the substrates.

According to another aspect of the invention,

there is provided a method for manufacturing a flat display element comprising a pair of substrates opposed to each other across a given gap and including respective peripheral edge portions thereof stuck on each other with a sealant, a plurality of spacer posts provided between the substrates and maintaining the gap between the substrates, and an optical modulation layer sealed in a region surrounded by the sealant. This method comprises: preparing a pair of motherboards greater than the substrates; forming a display forming portion on each motherboard; locating the sealant on at least one of the motherboards so as to surround the peripheral edge portion of the display forming portion and locating, on end portions of the motherboard, end spacers for maintaining the gap between the two motherboards and a tacker covering the end spacers; sticking the two motherboards on each other with the sealant, end spacers, and tacker between the two; aligning the two stuck motherboards with each other; tacking the two motherboards to each other by curing the tacker after the aligning; finally bonding the two motherboards to each other by curing the sealant after the tacking; and cutting the two motherboards outside the sealant after the final bonding so as to obtain the substrates.

According to the methods for manufacturing a flat display element arranged in this manner, the respective

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FIG. 2 is an exploded perspective view schematically showing two mother glass plates opposed to each other according to the manufacturing method of

the embodiment of the invention;

FIG. 3A is a sectional views taken along line IIIA-IIIA in FIG. 2 and showing a step of spreading a sealant and a dummy sealant,

5 FIG. 3B is a sectional views taken along line IIIB-IIIB in FIG. 2 and showing step of spreading a tackler,

10 FIGS. 3C, 3D and 3E are sectional views showing a step of sticking the mother glass plates on each other, step of curing the tackler, and step of cutting out a liquid crystal cell, respectively; and

15 FIGS. 4A and 4B are sectional views showing a step of spreading a tackler and a step of sticking mother glass plates on each other, respectively, in a manufacturing method according to a second embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

20 An embodiment of the present invention will now be described in detail with reference to the accompanying drawings. The following is a description of a liquid crystal display element as an example of a flat display element that is manufactured by a manufacturing method according to the present embodiment.

25 As shown in FIG. 1, a liquid crystal display element 10 comprises an array substrate 12 and an opposite substrate 11 that are opposed to each other across a given gap. A liquid crystal layer 14 as an

optical modulation layer is sealed between the two substrates 11 and 12. The respective peripheral edge portions of the array substrate 12 and the opposite substrate 11 are hermetically sealed with a sealant 15.

5 To keep the gap between the substrates fixed, a plurality of spacer posts 13 are arranged between the substrates 11 and 12. The substrate size and the display region size of the liquid crystal display element 10 are adjusted to $300 \times 250 \times 0.7$ mm and 253×190 mm, respectively.

10 The opposite substrate 11 is provided with a glass substrate 16 of $300 \times 250 \times 0.7$ mm. Formed on the glass substrate 16 are a color filter layer 17 and an opposite electrode 18 that is composed of an indium-tin oxide (hereinafter referred to as ITO). The color
15 filter layer 17 includes colored stripe layers of an acrylic resin, R (red), G (green), and B (blue), and black stripes (not shown).

20 The opposite substrate 11 has the spacer posts 13 of an acrylic resin, which protrude from the opposite electrode 18 toward the array substrate 12. The spacer posts 13 have a height of $5 \mu\text{m}$ and an arrangement density such that they occupy, for example, $1,000 \mu\text{m}^2$ for each pixel area of 1 mm^2 . Further, the spacer
25 posts 13 are arranged uniformly in regions opposite to non-display regions such as wiring layer regions (not shown) of the array substrate 12. An alignment film 23

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is formed on the opposite electrode 18 over the posts 13.

The spacer posts 13 may be located between the color filter layer 17 and the opposite electrode 18 or formed by stacking the colored layers of the color filter layer 17.

The array substrate 12 includes a glass substrate 20, which, like the opposite substrate 11, measures $300 \times 250 \times 0.7$ mm. A large number of scanning lines and signal lines are formed in a matrix on the glass substrate, and pixel electrodes 22 are provided individually in regions that are surrounded by the scanning and signal lines. Further, thin-film transistors (hereinafter referred to as TFT's) 21 for driving the liquid crystal layer 14 are arranged individually near the points of intersection of the scanning and signal lines and connected to the pixel electrodes 22. An alignment film 24 is deposited covering these lines, pixel electrodes 22, and TFT's. Polarization plates 26 and 27 are provided on the respective outer surfaces of the opposite substrate 11 and the array substrate 12, respectively.

The following is a description of the method for manufacturing the liquid crystal display element 10 constructed in this manner. First, rectangular mother glass plates 41 and 42 are prepared, as shown in FIG. 2. The glass plate 41 forms the glass substrate

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mother glass plate 42. The tacker 31 used is formed of an ultraviolet-curing resin loaded with end spacers 28 or silica spheres with a diameter of 5 μ m.

Subsequently, the mother glass plates 41 and 42 are opposed to each other so that the alignment films 23 and 24 are rubbed in directions at right angles to each other. The mother glass plates 41 and 42 are roughly aligned by means of a plane mounter (not shown) so that the shift of the pixel pattern pitches of the opposite substrate pattern 11a and the array substrate pattern 12a is within 5 μ m. Thereafter, the mother glass plates 41 and 42 are pressed under a pressure of 400 kgf and stuck on each other with the sealant 15, dummy sealant 30, and tacker 31, as shown in FIG. 3C.

Since the tacker 31 located in each of the four corners of the mother glass plate 42 is loaded with the end spacers 28, the mother glass plates 41 and 42 can be prevented from adhering to each other with a gap of about 5 μ m maintained by means of the end spacers 28 at their peripheral edge portions.

Thereafter, the mother glass plates 41 and 42 are aligned by means of an aligner (not shown) so that the shift of the pixel pattern pitches of the opposite substrate pattern 11a and the array substrate pattern 12a is within about 5 μ m. The alignment by means of the aligner required only five cycles of adjustment and about 10 seconds. Liquid crystal cells of the same

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and tacker used may be also selected freely.

The respective sizes of the motherboards and the flat display element and the like are not limited to the values according to the foregoing embodiments.

5 Further, a plurality of cells may be manufactured by a multi-manufacturing method in which a plurality of display element patterns are formed on each

motherboard. According to the foregoing embodiments, moreover, the sealant, dummy sealant, and tacker are
10 spread over the mother glass plate on the array-substrate side. Alternatively, however, they may be spread over the mother glass plate on the opposite-substrate side.

The present invention is applicable to the
15 manufacture of flat display elements that have spherical spacers or no spacers, as well as to ones that have spacer posts. Further, the invention is not limited to liquid crystal display elements, and may be also applied to some other flat display elements, such
20 as organic EL panels.

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